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(54) Vehicle control system for lane changing

Fahrzeug-Steuerungsystem zum Fahrspurwechsel

Système de gestion des changements de voie d'un véhicule

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Attachment 2.

Description

[0001] The present invention relates to a vehicle control system for controlling a vehicle of its own to follow a preceding vehicle while running in pursuit.

[0002] One known vehicle control system is disclosed in Japanese laid-open patent publication No. 6-144076. The disclosed vehicle control system controls a vehicle of its own based on the distance between the vehicle of its own and a preceding vehicle so as to follow the preceding vehicle.

[0003] The vehicle control system has a vehicle-to-vehicle distance detector for detecting the distance from its own vehicle which incorporates the vehicle control system to a preceding vehicle, a steering angle detector for detecting a steering angle of its own vehicle, a vehicle speed detector for detecting a vehicle speed of its own vehicle, a turn radius calculator for calculating the radius of a turn which its own vehicle is making based on the detected steering angle and the detected vehicle speed, an evaluator for evaluating the probability that the preceding vehicle is running in the lane of its own vehicle based on the calculated turn radius and the detected vehicle-to-vehicle distance, and a controller for controlling the throttle valve or brake of its own vehicle based on the evaluated probability.

[0004] In operation, the vehicle control system calculates the radius of a turn which its own vehicle is making based on the detected steering angle and the detected vehicle speed, and decides whether the preceding vehicle is present in the lane of its own vehicle based on the calculated turn radius and the detected vehicle-to-vehicle distance.

[0005] The vehicle control system quantitatively evaluates the possibility of an erroneous detection of a preceding vehicle based on the fact that such an erroneous detection depends on the turn radius and the vehicle-to-vehicle distance, and adjusts a control gain for the throttle valve or brake control process depending on the possibility of the erroneous detection, i.e., the probability that the detected preceding vehicle is positioned in the lane of its own vehicle, for thereby varying the characteristics of its own vehicle with which to follow the preceding vehicle.

[0006] Since the control gain is lowered with respect to a preceding vehicle whose possibility of being erroneously detected is high, the vehicle control system will not be adversely effected by a preceding vehicle running in an adjacent lane.

[0007] The disclosure of Japanese laid-open patent publication No. 6-144076 is silent about how the vehicle control system operates when its own vehicle changes lanes.

[0008] When the driver of its own vehicle turns the steering wheel clockwise to move its own vehicle from the present lane to a right lane, the conventional vehicle control system determines a front vehicle running on the right side as a new preceding vehicle to follow. At this time, when the driver returns the steering wheel counterclockwise to orient its own vehicle along the right lane, the conventional vehicle control system tends to determine a vehicle running in the original lane, from which its own vehicle has moved to the right lane, as a new preceding vehicle to follow.

[0009] Conversely, when the driver of the vehicle turns the steering wheel counterclockwise to move its own vehicle from the present lane to a left lane, the conventional vehicle control system determines a front vehicle on the left side as a new preceding vehicle to follow. At this time, when the driver returns the steering wheel clockwise to orient its own vehicle along the left lane, the conventional vehicle control system tends to determine a vehicle running in the original lane, from which the vehicle has moved to the left lane, as a new preceding vehicle to follow.

[0010] Specifically, such a problem will be described below with reference to FIGS. 1A - 1C and 2 of the accompanying drawings.

[0011] It is assumed that a vehicle Z of its own, i.e., a vehicle which incorporates the vehicle control system, follows a preceding vehicle P while running along a lane in a road RT, as shown in FIG. 1A, and then changes from the lane to an adjacent lane across a lane line CL, as shown in FIG. 1B, and after changing to the adjacent lane, its own vehicle Z follows a preceding vehicle Q in the adjacent lane, as shown in FIG. 1C.

[0012] FIG. 2 of the accompanying drawings shows the manner in which the steering angle θ of the vehicle Z varies when the vehicle Z changes the lanes. In FIG. 2, the steering angle θ is positive when the steering wheel of the vehicle Z is turned counterclockwise, and negative when the steering wheel of the vehicle Z is turned clockwise. The yaw rate of the vehicle Z is plotted in the same pattern as shown in FIG. 2 when the vehicle Z changes the lanes.

[0013] The steering angle θ goes through different values a - e shown in FIG. 2 as the vehicle Z moves through successive corresponding points a - e shown in FIG. 1B while changing the lanes.

[0014] If a preceding vehicle is determined based on the yaw rate or the steering angle of the vehicle Z without detecting the lane change, then the preceding vehicle may erroneously be determined when the steering wheel is returned in the vicinity of the point d.

[0015] Specifically, while the vehicle Z is running along the original lane, it locks on and follows the preceding vehicle P which is also running in the same lane. When the vehicle Z changes from the original lane to a left lane, it unlocks the preceding vehicle P, and moves into the left lane by turning the steering wheel clockwise. Immediately before the vehicle Z completes the lane change, the steering wheel of the vehicle Z is returned counterclockwise in the vicinity of the point p, and the vehicle Z tends to recognize the vehicle P as a preceding vehicle again.

[0016] Therefore, until the vehicle Z completes the

lane change, the vehicle Z cannot determine the vehicle Q definitely as a preceding vehicle. As a result, a relatively long period of time is spent from the time when the vehicle Z unlocks the preceding vehicle P to the time when the vehicle Z finally locks on the preceding vehicle Q. For this reason, the driver of the vehicle Z is likely to feel that the vehicle Z is not making the lane change smoothly.

[0017] European Patent Application EP-A-O 657 857 describes a vehicle control system corresponding to the preamble of claim 1. It deals with the problem of detecting a preceding vehicle during changes of direction.

[0018] It is therefore an object of the present invention to provide a vehicle control system for accurately determining a preceding vehicle to follow when changing lanes.

[0019] Another object of the present invention is to provide a vehicle control system which prevents a vehicle running obliquely in front of its own vehicle in a lane adjacent to a lane which its own vehicle reaches after changing lanes, from being determined as a preceding vehicle to follow.

[0020] These objects are achieved by a vehicle control system according to claim 1.

[0021] According to an aspect of the present invention, there is provided a vehicle control system for controlling its own vehicle to follow another vehicle, comprising a radar unit for detecting a relative distance from its own vehicle to a front vehicle in front of its own vehicle and a relative speed of the front vehicle with respect to its own vehicle, and outputting information representing the relative distance and the relative speed, a lane change detector for detecting a lane change which is made by its own vehicle and outputting a lane change signal indicative of the lane change, and a processor for estimating a future lane or path for its own vehicle from present running states of its own vehicle and the lane change signal from the lane change detector, and determining a preceding vehicle which its own vehicle is to follow based on the estimated future lane or path and the information outputted by the radar unit.

[0022] If a preceding vehicle were determined on the basis of the yaw rate or steering angle of its own vehicle without the detection of a lane change, a wrong vehicle would tend to be determined as a preceding vehicle when the steering wheel of its own vehicle is returned upon the lane change.

[0023] With the vehicle control system according to the present invention, however, since the lane change detector outputs a lane change signal representing a lane change, and the processor estimates a future lane or path based on the lane change signal, any wrong vehicle is prevented from being determined as a preceding vehicle.

[0024] Furthermore, because the processor estimates a future lane or path based on the lane change signal, it can clearly distinguish a lane or path for its own vehicle before and after the lane change.

[0025] According to another aspect of the present invention, there is provided a vehicle control system for controlling its own vehicle to follow another vehicle, comprising a radar unit for detecting a relative distance from its own vehicle to a front vehicle in front of its own vehicle and a relative speed of the front vehicle with respect to its own vehicle, and outputting information representing the relative distance and the relative speed, a lane change detector for detecting a lane change which is made by its own vehicle and outputting a lane change signal indicative of the lane change, and a processor for estimating a future lane or path for its own vehicle from present running states of its own vehicle, determining a preceding vehicle which its own vehicle is to follow based on the estimated future lane or path and the information outputted by the radar unit, and preventing its own vehicle from following the preceding vehicle in response to the lane change signal outputted by the lane change detector.

[0026] Inasmuch as its own vehicle is prevented from following the preceding vehicle upon the lane change, the vehicle control system is prevented from determining, as a preceding vehicle, a vehicle which is running obliquely in front of its own vehicle in a lane adjacent to the lane in which its own vehicle runs after the lane change.

[0027] The processor comprises means for determining a vehicle closest to its own vehicle in the estimated future lane or path therefor, as a preceding vehicle which its own vehicle is to follow based on the estimated future lane or path and the information outputted by the radar unit. After the lane change, the processor can continuously control its own vehicle to follow the preceding vehicle.

[0028] The lane change detector comprises a steering angle sensor for detecting a steering angle of its own vehicle and means for outputting the lane change signal when the detected steering angle is greater than a predetermined threshold. When the steering angle varies in excess of the predetermined threshold, the lane change detector can quickly detect a lane change. The lane change detector is also capable of detecting when its own vehicle is making a lane change and has completed a lane change.

[0029] The lane change detector comprises a yaw rate sensor for detecting a yaw rate of its own vehicle and means for outputting the lane change signal when the detected yaw rate is greater than a predetermined threshold. When the yaw rate varies in excess of the predetermined threshold, the lane change detector can quickly detect a lane change. The lane change detector is also capable of detecting when its own vehicle is making a lane change and has completed a lane change.

[0030] According to still another aspect of the present invention, there is provided a vehicle control system for controlling its own vehicle to follow another vehicle, comprising a radar unit for detecting a relative distance from its own vehicle to a front vehicle in front of its own

vehicle and a relative speed of the front vehicle with respect to its own vehicle, and outputting information representing the relative distance and the relative speed, a lane change detector for detecting a lane change which is made by its own vehicle and outputting a lane change signal indicative of the lane change, and a processor for estimating a future lane or path for its own vehicle from the lane change signal from the lane change detector, unlocking a preceding vehicle which its own vehicle has followed, and determining a new preceding vehicle which its own vehicle is to lock on based on the estimated future lane or path and the information outputted by the radar unit.

[0031] The above and other objects, features, and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings which illustrate a preferred embodiment of the present invention by way of example.

FIGS. 1A, 1B, and 1C are schematic plan views showing the positional relationship between vehicles when one of the vehicles makes a lane change;
FIG. 2 is a diagram showing the manner in which the steering angle of a vehicle which makes a lane change varies with time;
FIG. 3 is a block diagram of a vehicle control system according to the present invention;
FIG. 4 is a flowchart of an operation sequence of a processor of the vehicle control system shown in FIG. 3;
FIG. 5 is a diagram showing the manner in which the steering angle of a vehicle which makes a lane change varies with time, and a threshold value;
FIG. 6A is a schematic plan view illustrative of map information representing an estimated path for a vehicle before making a lane change and the position of a preceding vehicle;
FIG. 6B is a schematic plan view illustrative of map information representing a tentative path for a vehicle after making a lane change and the position of a preceding vehicle; and
FIG. 7 is a schematic plan view illustrative of map information representing a history of movement of a vehicle and other vehicles running in front of the vehicle.

[0032] As shown in FIG. 3, a vehicle control system 1 according to the present invention generally comprises a radar unit 2 for detecting the distance between a vehicle of its own which incorporates the vehicle control system 1 and another vehicle which runs in front of its own vehicle and the speed of the other vehicle with respect to its own vehicle, and outputting information representing the distance and the speed, and a processor 6 for estimating a future lane or path for its own vehicle and determining a preceding vehicle which its own vehicle is to follow, based on the estimated future lane or path and the information from the radar unit 2.

[0033] The vehicle control system 1 also has a throttle valve actuator 7 and a brake actuator 8. The throttle valve actuator 7 or the brake actuator 8 is controlled by the processor 6 to increase or reduce the vehicle speed of its own vehicle for allowing its own vehicle to automatically follow a preceding vehicle while maintaining a sufficient vehicle-to-vehicle distance between its own vehicle and the preceding vehicle.

[0034] The vehicle control system 1 further includes a lane change detector 5 for detecting a lane change made by its own vehicle and outputting a lane change signal, and a vehicle speed sensor 3 for detecting a vehicle speed of its own vehicle.

[0035] The processor 6 estimates the future lane or path for its own vehicle based on a lane change signal from the lane change detector 5. The processor 6 may comprise a microcomputer system, a DSP (digital signal processor), or an ECU (electronic control unit).

[0036] The radar unit 2 radiates an electromagnetic wave or a laser beam in front of its own vehicle, receives an echo wave or beam reflected from a vehicle in front of its own vehicle, and detects the distance between its own vehicle and another vehicle which runs in front of its own vehicle and the speed of the other vehicle with respect to its own vehicle.

[0037] The radar unit 2 may comprise an FM-CW radar unit, and may be arranged to detect the relative distance and the relative speed from the frequency of a beat signal which is generated by mixing the transmitted electromagnetic wave and the echo wave.

[0038] The transmitted electromagnetic wave may have a frequency ranging from 30 GHz to 150 GHz.

[0039] The lane change detector 5 comprises a yaw rate sensor 51 for detecting a yaw rate of its own vehicle, a steering angle sensor 52 for detecting a steering angle of its own vehicle, a high-precision navigation system 53, a TV camera 54 for imaging a scene in front of its own vehicle, and a CPU 55 for performing various calculations. The lane change detector 5 may additionally have a D(differential)-GPS (global positioning system).

[0040] A detected yaw rate signal from the yaw rate sensor 51, a detected steering angle signal from the steering angle sensor 52, a detected vehicle speed signal from the vehicle speed sensor 3, a signal from the navigation system 53, and a video signal from the TV camera 54 are supplied to the CPU 55 and the processor 6.

[0041] The CPU 55 has a certain threshold level for determining a lane change, which is established in advance with respect to a detected signal from the yaw rate sensor 51 or the steering angle sensor 52.

[0042] When the yaw rate sensor 51 or the steering angle sensor 52 generates a detected signal in excess of the threshold level, the CPU 55 determines that its own vehicle is making a lane change, and issues a lane change signal to the processor 6.

[0043] The CPU 55 also calculates a history of move-

ment of its own vehicle from the vehicle speed and steering angle (or yaw rate) of its own vehicle. If a lateral displacement corresponding to a lane change occurs in the calculated history of movement, then the CPU 55 determines that its own vehicle is making a lane change, and issues a lane change signal to the processor 6.

[0044] The CPU 55 can also determine that its own vehicle is making a lane change from positional information of its own vehicle supplied from the navigation system 53.

[0045] The CPU 55 can also determine that its own vehicle is making a lane change based on the operation of a direction indicator of its own vehicle.

[0046] Furthermore, the CPU 55 identifies a road and a white marking line on the road based on a video signal from the TV camera 54. The CPU 55 determines that its own vehicle is making a lane change from the identified white marking line, the yaw rate or the steering wheel of its own vehicle.

[0047] Based on the information of a vehicle running in front of its own vehicle from the TV camera 54, the vehicle speed from the vehicle speed sensor 3, the video signal from the TV camera 4, the lane change signal from the lane change detector 5, the raw rate from the yaw rate sensor 51, and the steering angle from the steering angle sensor 52, the processor 6 controls the throttle valve actuator 7 or the brake actuator 8 to increase or reduce the vehicle speed of its own vehicle for allowing its own vehicle to automatically follow a preceding vehicle while maintaining a sufficient vehicle-to-vehicle distance between its own vehicle and the preceding vehicle.

[0048] The processor 6 also calculates a width W (see FIGS. 6A and 6B) of the lane in which its own vehicle is running, from the video signal from the TV camera 4.

[0049] The processor 6 has a front vehicle information processing unit 61 which plots in a common coordinate system the relative position of a vehicle in front of its own vehicle, obtained from the radar unit 2, and a future path for its own vehicle estimated from the vehicle speed and steering angle (or yaw rate) of its own vehicle. The front vehicle information processing unit 61 also temporarily stores map information representing the plotted position and future path.

[0050] The front vehicle information processing unit 61 further plots in an absolute coordinate system the relative position of a vehicle in front of its own vehicle, obtained from the radar unit 2, and information of movement of its own vehicle, obtained from the vehicle speed and steering angle (or yaw rate) of its own vehicle. The front vehicle information processing unit 61 also temporarily stores map information representing a history of movement of its own vehicle and the front vehicle.

[0051] The processor 6 also has a preceding vehicle determining unit 62 which determines a front vehicle positioned on the estimated path and at a shortest distance from its own vehicle, as a preceding vehicle which its own vehicle is to follow, in the map information representing the estimated path for its own vehicle and the position of the front vehicle in the common coordinate system.

[0052] Operation of the processor 6 will be described below with reference to FIG. 4.

[0053] The processor 6 repeatedly executes a succession of steps shown in FIG. 4.

[0054] In step S1, the processor 6 decides whether its own vehicle is making a lane change or not from the lane change signal. If its own vehicle is not making a lane change, then the processor 6 decides whether there is a preceding vehicle which its own vehicle is locking on in step S9. If there is a preceding vehicle which its own vehicle is locking on, then the processor 6 continuously controls its own vehicle to follow the preceding vehicle in step S8. A mode in which its own vehicle runs while following the preceding vehicle is referred to as a pursuit vehicle control mode. If there is not a preceding vehicle which its own vehicle is locking on, then the operation sequence shown in FIG. 4 is finished, and the processor 6 controls its own vehicle to run in a manual control mode or an automatic cruise control mode.

[0055] The pursuit vehicle control mode, the manual control mode, and the automatic cruise control mode, and switching between these modes are indicated to the driver of its own vehicle with a voice, a buzzer, or a lamp.

[0056] If its own vehicle is making a lane change, then the processor 6 decides whether there is a preceding vehicle which its own vehicle is locking on presently or immediately prior to the lane change (or there is a vehicle presently determined as a preceding vehicle) or not in step S2. If there is a preceding vehicle which is being locked on (automatically tracked), then the processor 6 immediately unlocks the preceding vehicle or cancels the decision to determine the vehicle as the preceding vehicle in step S3.

[0057] In step S4, the processor 6 calculates a start time Ts (also see FIG. 5) when the lane change has started from a detection time Tt when the lane change has been detected, and also detects a direction (left or right) of the lane change.

[0058] In step S5, the processor 6 extracts map information of the estimated path for its own vehicle at the start time Ts from the map information representing the position of the front vehicle and the estimated path for its own vehicle. The processor 6 then moves the estimated path for its own vehicle in the detected direction (left or right) of the lane change for the calculated width W in the extracted map information, and uses the moved path as a tentative path.

[0059] In step S6, the processor 6 decides whether there is a vehicle in front of its own vehicle in the tentative path on the map information in which the tentative path is plotted.

[0060] If there is a vehicle in front of its own vehicle in the tentative path, then the processor 6 determines a front vehicle positioned at a shortest distance from its own vehicle as a preceding vehicle in step S7.

[0061] The processor 6 then controls its own vehicle to follow the preceding vehicle in step S8.

[0062] If there is not a vehicle in front of its own vehicle in the tentative path, then the processor 6 determines there is no preceding vehicle after the lane change, and controls its own vehicle to run in the automatic cruise control mode.

[0063] FIG. 5 shows the manner in which the steering angle θ of the vehicle varies when the vehicle makes the lane change. The yaw rate of the vehicle varies in the same pattern as the steering angle θ.

[0064] The processor 6 uses the time when the steering angle θ exceeds a threshold level θt as the detection time Tt. The processor 6 calculates the start time Ts from the detection time Tt as described above.

[0065] The processor 6 is capable of temporarily storing the detected yaw rate from the yaw rate sensor 51 and the detected steering angle from the steering angle sensor 52.

[0066] The processor 6 and the CPU 55 may be combined as a single processing and controlling system.

[0067] FIG. 6A illustrates map information representing an estimated path for a vehicle before making a lane change and the position of a preceding vehicle, and FIG. 6B illustrates map information representing a tentative path for a vehicle after making a lane change and the position of a preceding vehicle.

[0068] In FIGS. 6A and 6B, a vehicle Z which incorporates the vehicle control system runs in one of lanes of a road RT which are divided by a lane line CL, each of the lanes having a width W. FIG. 6A shows an estimated path K1 for the vehicle Z in the present lane, and FIG. 6B shows a tentative path K2 for the vehicle Z in the adjacent lane.

[0069] Before making a lane change, the vehicle Z runs in the present lane while following a preceding vehicle P. The processor 6 estimates the path K1 for the vehicle Z in the direction of the preceding vehicle P.

[0070] If the processor 6 recognizes a lane change based on a lane change signal from the lane change signal, then the processor 6 moves the estimated path K1 for its own vehicle in the direction of the lane change for the width W, thus obtaining the tentative path K2 in the adjacent lane to which the lane change is made. Therefore, a front vehicle Q running in the tentative path K2 in the adjacent lane can quickly be determined as a new preceding vehicle.

[0071] FIG. 7 illustrates map information representing a history of movement of a vehicle Z and front vehicles P, Q running in front of the vehicle Z.

[0072] In FIG. 7, positions of the vehicles Z, P, Q are plotted in an absolute coordinate system, e.g., an X-Y coordinate system, at successive times t1, t2, t3. When the vehicle Z makes a lane change, the processor 6 may determine a preceding vehicle on a historical map representing such plotted positions of the vehicles Z, P, Q. The processor 6 may estimate a future path for the vehicle Z based on the history of movement of the front vehicles P, Q.

[0073] When making a lane change, the driver may temporarily interrupt the pursuit vehicle control mode, and may subsequently resume the pursuit vehicle control mode by operating a resume switch.

[0074] Alternatively, when a lane change is made, the processor 6 may automatically interrupt the pursuit vehicle control mode, and subsequently resume the pursuit vehicle control mode when the driver operate the resume switch.

[0075] The vehicle control system according to the illustrated embodiment estimates a future path for its own vehicle and uses the estimated future path to determine a preceding vehicle. However, the vehicle control system may be arranged to estimate a future lane for its own vehicle and use the estimated lane to determine a preceding vehicle.

[0076] The vehicle control system according to the present invention offers various advantages as described below.

[0077] When its own vehicle makes a lane change while in the pursuit vehicle control mode, it can quickly unlock the preceding vehicle which it has locked on thus far, and quickly calculate information of a front vehicle which its own vehicle has to lock on next.

[0078] Therefore, the driver of its own vehicle can quickly accelerate or decelerate the vehicle in the lane change just like the driver does in the manual control mode. The vehicle can thus be controlled smoothly to follow the preceding vehicle without the driver's feeling embarrassed or uncomfortable upon the lane change.

[0079] Furthermore, since a lane change from one lane to an adjacent lane is first detected by the lane change detector and a preceding vehicle is then determined in the adjacent lane, any front vehicle running in another lane is prevented from being determined as a preceding lane.

[0080] Although a certain preferred embodiment of the present invention have been shown and described in detail, it should be understood that various changes and modifications may be made therein without departing from the scope of the appended claims.

[0081] A vehicle control system for controlling its own vehicle to follow another vehicle has a radar unit. The radar unit has function for detecting a relative distance from its own vehicle to a front vehicle in front of its own vehicle and a relative speed of the front vehicle with respect to its own vehicle, and outputting information representing the relative distance and the relative speed. A lane change detector detects a lane change which is made by its own vehicle and outputs a lane change signal indicative of the lane change. A processor estimates a future lane or path for its own vehicle from the lane change signal from the lane change detector, unlocks a preceding vehicle which its own vehicle has followed, and determines a new preceding vehicle which its own vehicle is to lock on based on the estimated future lane or path and the information outputted by the radar unit.

Claims

1. A vehicle control system for controlling its own vehicle to follow another vehicle, comprising

- a radar or laser unit (2) suitable for detecting a relative distance from its own vehicle to a front vehicle in front of its own vehicle and a relative speed of the front vehicle with respect to its own vehicle, and for outputting information representing the relative distance and the relative speed;
- an estimating and determining processor (6) suitable for estimating a future lane or path for its own vehicle from the present running state of the vehicle and suitable for determining preceding vehicles on adjacent lanes of a street which its own vehicle is to follow based on the estimated future lane or path and the information outputted by said radar or laser unit (2),

characterized in that

- a lane change detector (5) is provided suitable for detecting a lane change which is made by its own vehicle and outputting a lane change signal indicative of said lane change in case at least one of the following conditions are given:

  (a) a steering angle detected by a steering angle sensor (52) is greater than a predetermined value;
  (b) a yaw rate detected by a yaw rate sensor (51) is greater than a predetermined value;
  (c) a lateral displacement corresponding to a lane change is detected by a processing unit 55 based on map information calculated on a history of movement of its own vehicle or provided by a navigation system (53);
  (d) a crossing of a marking line between adjacent lanes of the street is detected by a video signal processing unit (54, 55),

and that the estimating and determining processor (6) estimates the future lane or path of its own vehicle and determines the preceding vehicle which its own vehicle is to follow based on the lane change signal from said lane change detector.

2. A vehicle control system according to claim 1, wherein said estimating and determining processor (6) comprises means suitable for determining a vehicle closest to its own vehicle in the estimated future lane or path therefor as a preceding vehicle which its own vehicle is to follow based on the estimated future lane or path and the information outputted by the radar or laser unit (2).

3. A vehicle control system according to claim 1 or 2, wherein the estimating and determining processor (6) prevents its own vehicle from following a previously determined preceding vehicle which its own vehicle has followed until the output of the lane change signal.

4. A vehicle control system according to claim 3, wherein the estimating and determining processor (6), upon output of the lane change signal, determines a new preceding vehicle which its own vehicle is to follow based on the estimated future lane or path and the information outputted by said radar unit.

Patentansprüche

1. Fahrzeugsteuer/regelsystem zum Steuern eines eigenen Fahrzeugs, um einem anderen Fahrzeug zu folgen, umfassend

- eine Radar- oder Lasereinheit (2), die geeignet ist, um einen relativen Abstand von dem eigenen Fahrzeug zu einem vorderen Fahrzeug vor dem eigenen Fahrzeug sowie eine Relativgeschwindigkeit des vorderen Fahrzeugs in Bezug auf das eigene Fahrzeug zu erfassen und Information auszugeben, die den relativen Abstand und die Relativgeschwindigkeit repräsentiert;
- einen Schätz- und Bestimmungsprozessor (6), der geeignet ist, um eine künftige Fahrbahn oder einen künftigen Weg für das eigene Fahrzeug aus dem gegenwärtigen Fahrzustand des Fahrzeugs zu schätzen, und geeignet ist, um vorausfahrende Fahrzeuge auf benachbarten Fahrbahnen einer Straße, denen das eigene Fahrzeug folgen soll, auf der Basis der geschätzten künftigen Fahrbahn oder des geschätzten künftigen Wegs und der von der Radar- oder Lasereinheit (2) ausgegebenen Information zu bestimmen,

dadurch gekennzeichnet, dass

- ein Fahrbahnwechseldetektor (5) vorgesehen ist, der geeignet ist, um einen von dem eigenen Fahrzeug durchgeführten Fahrbahnwechsel zu erfassen, und ein Fahrbahnwechselsignal auszugeben, das den Fahrbahnwechsel anzeigt, falls zumindest eine der folgenden Bedingungen vorliegt:

  (a) ein von einem Lenkwinkelsensor (52) erfasster Lenkwinkel ist größer als ein vor-

bestimmter Wert;
(b) eine von einem Gierratensensor (51) erfasste Gierrate ist größer als ein vorbestimmter Wert;
(c) ein einem Fahrbahnwechsel entsprechender Querversatz wird von einer Prozessoreinheit (55) auf der Basis von Karteninformation erfasst, die nach einer Bewegungshistorie des eigenen Fahrzeugs berechnet oder von einem Navigationssystem (53) bereitgestellt wird;
(d) das Überqueren einer Markierungslinie zwischen benachbarten Fahrbahnen einer Straße wird von einer Videosignalprozessoreinheit (54, 55) erfasst,

und dass der Schätz- und Bestimmungsprozessor (6) die künftige Fahrbahn oder den künftigen Weg des eigenen Fahrzeugs schätzt und das vorausfahrende Fahrzeug, dem das eigene Fahrzeug folgen soll, auf der Basis des Fahrbahnwechselsignals von dem Fahrbahnwechseldetektor bestimmt.

2. Fahrzeugsteuer/regelsystem nach Anspruch 1, wobei der Schätz- und Bestimmungsprozessor (6) Mittel umfasst, die geeignet sind, um ein Fahrzeug, das dem eigenen Fahrzeug auf der geschätzten künftigen Fahrbahn oder dem geschätzten künftigen Weg dafür am nächsten ist, als ein vorausfahrendes Fahrzeug zu bestimmen, dem das eigene Fahrzeug folgen soll, auf der Basis der geschätzten künftigen Fahrbahn oder des geschätzten künftigen Wegs und der von der Radaroder Lasereinheit (2) ausgegebenen Information.

3. Fahrzeugsteuer/regelsystem nach Anspruch 1 oder 2, wobei der Schätzund Bestimmungsprozessor (6) verhindert, dass das eigene Fahrzeug einem zuvor bestimmten vorausfahrenden Fahrzeug folgt, dem das eigene Fahrzeug bis zur Ausgabe des Fahrbahnwechselsignals gefolgt ist.

4. Fahrzeugsteuer/regelsystem nach Anspruch 3, wobei der Schätz- und Bestimmungsprozessor (6), bei Ausgabe des Fahrbahnwechselsignals, ein neues vorausfahrendes Fahrzeug, dem das eigene Fahrzeug folgen soll, auf der Basis der geschätzten künftigen Fahrbahn oder des geschätzten künftigen Wegs und der von der Radareinheit ausgegebenen Information bestimmt.

Revendications

1. Systéme de commande de véhicule pour commander le véhicule qui le comporte afin qu'il suive un autre véhicule, comprenant :

- une unité à radar ou à laser (2) appropriée pour la détection d'une distance relative entre le véhicule qui le comporte et un véhicule avant situé à l'avant du véhicule qui le comporte et d'une vitesse relative du véhicule avant par rapport au véhicule qui le comporte, et pour fournir en sortie des informations représentant la distance relative et la vitesse relative ;
- un processeur d'estimation et de détermination (6) approprié pour l'estimation d'une voie ou d'un trajet futur pour le véhicule qui le comporte à partir de l'état de déplacement présent du véhicule et approprié pour la détermination de véhicules précédents sur des voies adjacentes d'une route que doit suivre le véhicule qui le comporte sur la base de la voie ou du trajet futur estimé et des informations fournies en sortie par ladite unité à radar ou à laser (2),

caractérisé en ce que

- un détecteur de changement de voie (5) est prévu et est approprié pour la détection d'un changement de voie qui est effectué par le véhicule qui le comporte et pour fournir en sortie un signal de changement de voie représentatif dudit changement de voie dans le cas où au moins l'une des conditions suivantes est satisfaite :

(a) un angle de direction détecté par un capteur d'angle de direction (52) est supérieur à une valeur prédéterminée ;
(b) une vitesse de lacet détectée par un capteur de vitesse de lacet (51) est supérieure à une valeur prédéterminée ;
(c) un déplacement latéral correspondant à un changement de voie est détecté par une unité de traitement 55 sur la base d'informations cartographiques calculées à partir d'un historique du déplacement du véhicule qui le comporte ou fournies par un système de navigation (53) ;
(d) un franchissement d'une ligne de marquage entre des voies adjacentes de la route est détecté par une unité de traitement de signal vidéo (54, 55),

et en ce que le processeur d'estimation et de détermination (6) estime la voie ou le trajet futur du véhicule qui le comporte et détermine le véhicule précédent que doit suivre le véhicule qui le comporte sur la base du signal de changement de voie provenant dudit détecteur de changement de voie.

2. Système de commande de véhicule selon la revendication 1, dans lequel ledit processeur d'estimation et de détermination (6) comprend des moyens ap-

propriés pour la détermination d'un véhicule le plus proche du véhicule qui le comporte sur la voie ou le trajet futur estimé pour celui-ci en tant que véhicule précédent, que doit suivre le véhicule qui le comporte sur la base de la voie ou du trajet futur estimé et des informations fournies en sortie par l'unité à radar ou à laser (2).

3. Système de commande de véhicule selon la revendication 1 ou 2, dans lequel le processeur d'estimation et de détermination (6) empêche le véhicule qui le comporte de suivre un véhicule précédent déjà déterminé qu'a suivi le véhicule qui le comporte jusqu'à la fourniture en sortie du signal de changement de voie.

4. Système de commande de véhicule selon la revendication 3, dans lequel le processeur d'estimation et de détermination (6), lors de la fourniture en sortie du signal de changement de voie, détermine un nouveau véhicule précédent que doit suivre le véhicule qui le comporte sur la base de la voie ou du trajet futur estimé et des informations fournies en sortie par ladite unité à radar.

FIG. 1A

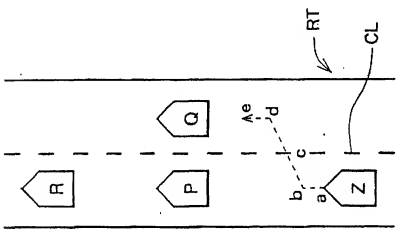

FIG. 1B

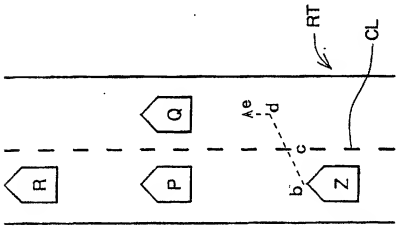

FIG. 1C

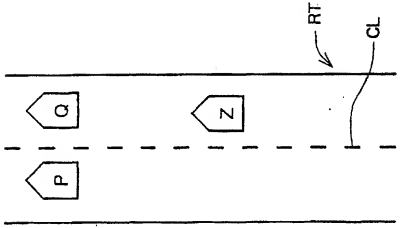

FIG. 2

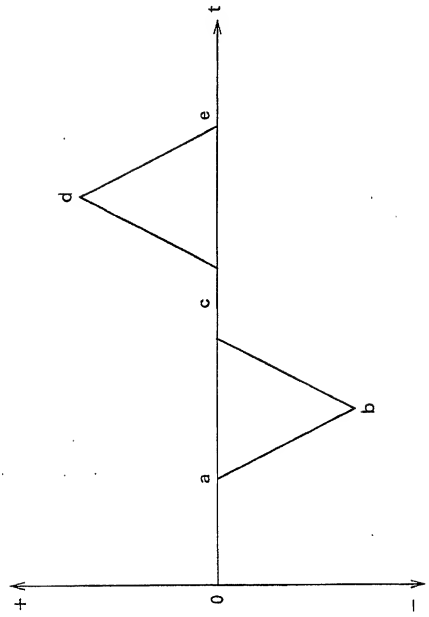

FIG. 3

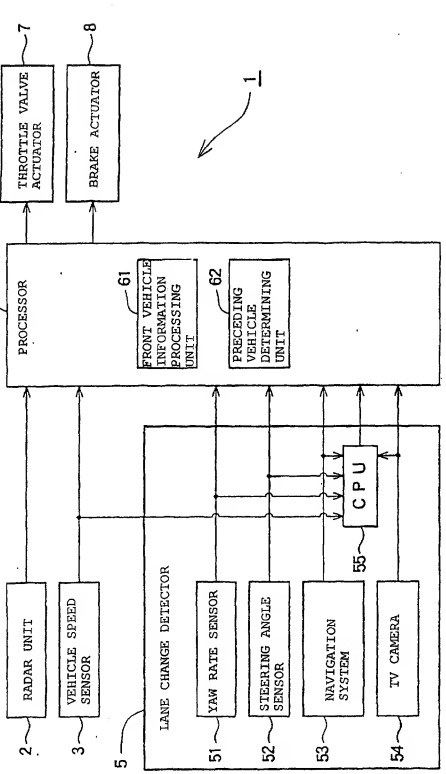
1
2
RADAR UNIT
3
VEHICLE SPEED SENSOR
5
LANE CHANGE DETECTOR
51
YAW RATE SENSOR
52
STEERING ANGLE SENSOR
53
NAVIGATION SYSTEM
54
TV CAMERA
55
CPU
6
PROCESSOR
61
FRONT VEHICLE INFORMATION PROCESSING UNIT
62
PRECEDING VEHICLE DETERMINING UNIT
7
THROTTLE VALVE ACTUATOR
8
BRAKE ACTUATOR

FIG. 4

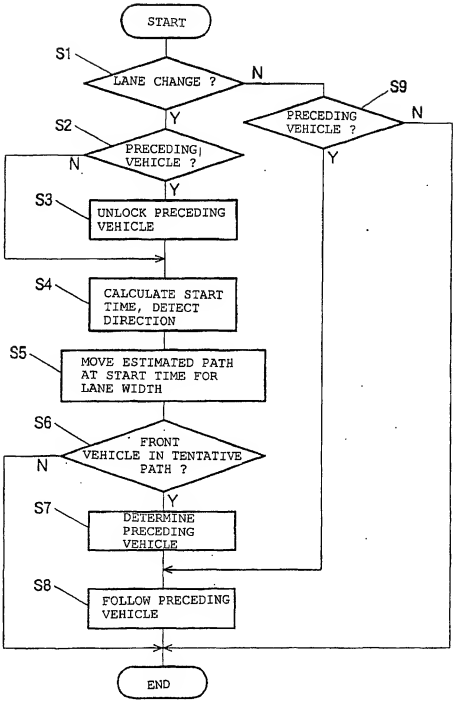
START
S1
LANE CHANGE ?
N
Y
S9
PRECEDING VEHICLE ?
N
Y
S2
PRECEDING VEHICLE ?
N
Y
S3
UNLOCK PRECEDING VEHICLE
S4
CALCULATE START TIME, DETECT DIRECTION
S5
MOVE ESTIMATED PATH AT START TIME FOR LANE WIDTH
S6
FRONT VEHICLE IN TENTATIVE PATH ?
N
Y
S7
DETERMINE PRECEDING VEHICLE
S8
FOLLOW PRECEDING VEHICLE
END

FIG. 5

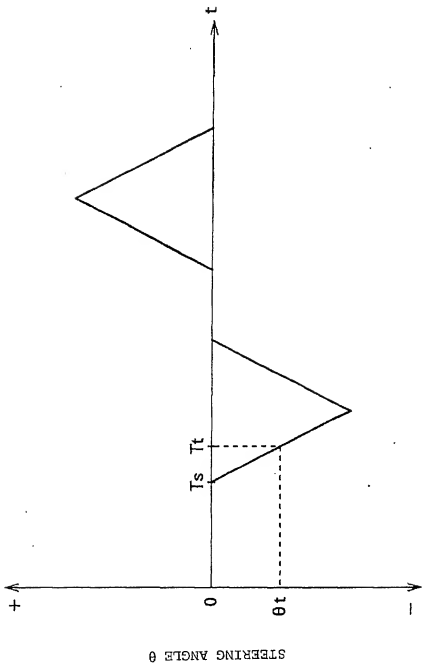

FIG. 6A

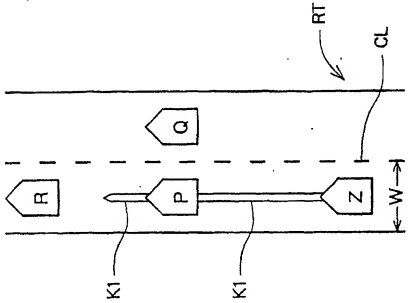

FIG. 6B

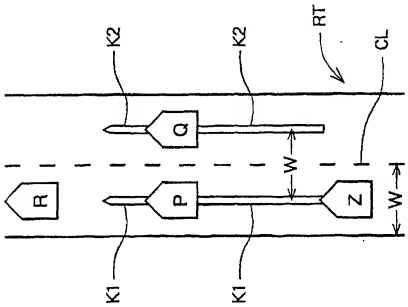
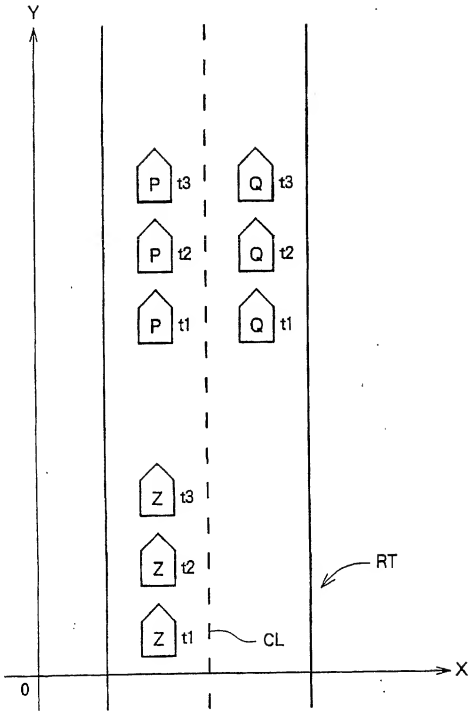
FIG. 7